

## **CRUISE RESULTS**

NOAA Ship *Pisces*

Cruise No. PC 21-04

Summer Northeast Ecosystem Monitoring Survey

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DATE: 02November2021

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02November2021

## **CRUISE RESULTS**

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### ***CRUISE PERIOD AND AREA***

NOAA Ship *Pisces* sampled a total of 149 stations on the Summer Ecosystem Monitoring Survey (EcoMon). The vessel sailed from Pier 2 at the Naval Station in Newport, Rhode Island, on 05 August and returned 19 August 2021. The survey sampled as far south as a line of stations south of Delaware Bay, so that stations in southernmost part of the Mid-Atlantic Bight were not covered. However, the survey was able to sample almost every station in the Southern New England, Georges Bank and the Gulf of Maine regions. Favorable weather and sea conditions during the entire survey allowed for supplemental stations to be added on the end of the cruise. Sample stations were added adjacent to Nantucket Shoals, near foraging right whales and in and around wind energy lease areas.

### ***OBJECTIVES***

The principal objective of this survey was to assess the pelagic components of the Northeast U.S. Continental Shelf Ecosystem from water currents to plankton, pelagic fishes, marine mammals, sea turtles, and seabirds. The spatial distribution of the following parameters was quantified: water properties, phytoplankton, microzooplankton, mesozooplankton, pelagic fish and invertebrates. Both traditional and novel techniques and instruments were used. Thus, operational objectives of this cruise were to:

- (1) Collect biological data with bongo plankton nets.
- (2) Collect ocean acidification and eDNA samples with rosette water sampler
- (3) Collect underway data using TSG, SCS, EK60, and ADCP.
- (4) Collect marine mammal and seabird observations.
- (5) Collect pteropods from ocean acidification stations
- (6) Collect online data and imagery of phytoplankton and ciliates using Imaging FlowCytobot.
- (7) Collect supplemental samples for energy density estimates of plankton.

## ***METHODS***

The survey originally consisted of 155 stations at which the vessel planned to stop and lower instruments over the side of the vessel from an A-frame and two conductive-wire winches. Due to time constraints of the number of sea days allotted, a decision was made to not visit the southern-most part of the Mid-Atlantic Bight region. A total of 149 stations were sampled from Delaware Bay north (Figure 1).

Plankton and hydrographic sampling were conducted with double oblique tows using the 61-cm bongo sampler and a Seabird CTD. The tows extended to approximately 5 meters above the bottom, or to a maximum depth of 200 meters. All plankton tows were conducted at a ship speed of 1.5 – 2.0 knots. Plankton sampling gear consisted of a 61-centimeter diameter aluminum bongo frame with two 335-micron nylon mesh nets equipped with analog flowmeters that recorded the number of revolutions during the tow. A 20-cm diameter PVC bongo frame fitted with paired 165-micron nylon mesh nets was added to the towing wire one half meter above the Seabird CTD and towed together with the large aluminum bongo frame at randomly selected stations to collect plankton for Census of Marine Zooplankton (CMarZ). No flowmeters were deployed with the 20-cm bongos. At most other plankton stations, a 20-cm frame with 335-micron mesh nets were deployed above the standard CTD/61-cm Bongo sampler. A 45-kilogram lead weight was attached by a 20-centimeter length of 3/8-inch diameter chain below the aluminum bongo frame to depress the net samplers. The plankton sampling gear was deployed off the starboard side of the vessel at the side-sampling station using an A-frame and the forward conducting cable winch. Tow depth was monitored in real time with a Seabird CTD profiler. The Seabird CTD profiler provided simultaneous depth, temperature, and salinity during each plankton tow. A Power Data Interface Module (PDIM) signal booster was used to facilitate data transfer at high baud rates over more than 1600 meters of conducting wire spooled onto the oceanic winch. After retrieval, both the large and small bongo nets were washed down with seawater on a table set up on the deck of the sampling area to obtain the plankton samples.

The 61-centimeter bongo plankton samples were preserved in a 5% solution of formalin in seawater. The samples from the 20-centimeter bongo nets were preserved in 95% ethanol, which was changed once, 24 hours after the initial preservation.

A Seabird 911+ CTD was deployed on a rosette frame with a carousel water sampling system (SBE32) and 12 10-liter Niskin bottles at all fixed stations. The package was deployed from the starboard side-sampling station, using the A-frame and conducting cable winch. This SBE9/11+ CTD and rosette package was deployed on vertical casts, collecting profiles of water temperature, salinity, chlorophyll-a and oxygen levels. Water samples were collected by the Niskin sampling bottles at multiple depths along the upcast to be processed ashore for nutrients, carbonate chemistry, and environmental DNA. Dissolved Inorganic Carbon (DIC) and nutrient samples were taken from the same bottle at three depths: surface, mid-water, and bottom to ensure the best possible correlation between the DIC and nutrient parameters. An additional nutrient sample was taken from the chlorophyll-max layer. Analysis for chlorophyll-a levels from water samples was conducted onboard the vessel using a Turner Designs 10-AU fluorometer and a filtration setup. Water samples for the chlorophyll-a analysis were drawn from the surface, chlorophyll-max layer and from one depth below the chlorophyll-max layer. These were taken as a check for the submersible fluorometer mounted on the rosette. Water

samples were also collected and filtered from multiple depths for researchers to capture eDNA samples to analyze for fish DNA signatures. Samples were collected from surface, bottom, chlorophyll-a max layer, and above and below the thermocline.

The Scientific Computer System (SCS) recorded the output from the thermosalinograph, Simrad EK60 Scientific echo sounder, and Acoustic Doppler Profiler. The ship's retractable keel was set to the intermediate depth to collect the best available acoustic data and allow for safe navigation in near shore stations. Records were given a time-date stamp by the GPS unit. In addition, an Imaging FlowCytobot (IFCB) unit was plumbed into the flow-through seawater system in the CTD lab. This device captured images of diatoms, dinoflagellates and marine ciliates on an independent computer provided by the Woods Hole Oceanographic Institution (WHOI). Marine mammal and seabird observations and photography were conducted from the bridge and flying bridge by seabird and marine mammal observers.

## ***RESULTS***

NOAA Ship *Pisces* sampled a total of 149 stations on the Summer Ecosystem Monitoring Survey. A summary of routine survey activities for each is presented in Table 1 and a total number of collections by deployment type are presented in Table 2. Areal coverage for the cruise is shown in Figure 1. NOAA Ship *Pisces* sailed from Newport, Rhode Island, on 05 August at 1400 hours EDT. Sampling started just outside of Narragansett Bay. The vessel sampled an inshore trackline on its way south to stations just north of the entrance to Delaware Bay. This marked the southernmost part of the cruise following a decision made to start heading back north to ensure more complete coverage of the northern survey areas, particularly the Gulf of Maine. We made a small detour on 15 August to search for some surface drifters released by Wells National Estuarine Research Reserve as part a larval lobster study. The drifters were released in coastal Maine in July, and were headed to Georges Bank, then parts unknown. We were asked to keep an eye out for them, and made the diversion to search for them when our trackline crossed theirs. Unfortunately, the drifter design had very little visible above the water, and we could not locate them in the sea conditions we had that day. Otherwise, good weather allowed rapid progress along the trackline. Regional coverage of planned operations (n = 155) ranged from 35 % in the Mid-Atlantic Bight, 98 % in the Gulf of Maine, and 100 % and Southern New England and Georges Bank. We were also able to conduct some supplemental sampling in the Southern New England region on the last days of the cruise.

## ***DISPOSITION OF SAMPLES AND DATA***

Most plankton and water samples, and data were delivered to the NEFSC Oceans and Climate Branch in Narragansett, Rhode Island, and Woods Hole, Massachusetts, for quality control processing and further analyses. DIC water samples were sent to NOAA Atlantic Oceanographic and Meteorological Laboratory in Miami, Florida. Filters collected for eDNA analysis were taken to NEFSC Ecosystem and Aquaculture Division in Milford, Connecticut. The CMarZ samples and associated data were delivered to the Woods Hole Oceanographic Institution (WHOI). The nutrient samples were delivered to the University of Rhode Island. The ImagingFlowCytobot unit and data were delivered to WHOI. Seabird and marine mammal observation data were delivered to NEFSC Protected Species Branch, Woods Hole, Massachusetts. Simrad EK60 Scientific echo sounder data was delivered to NEFSC Ecosystem Surveys Branch, Woods Hole, Massachusetts.

***SCIENTIFIC PERSONNEL***

National Marine Fisheries Service, NEFSC, Narragansett, RI  
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Table 1. Summary of deployments and samples collected at 149 stations at which the NOAA Ship Pisces stopped to lower instruments over the side during Cruise No. PC 21-04. Latitude and Longitude are shown in decimal degrees. CTD/Bongo Oblique = 61 cm bongo Standard Protocol, CTD Profile/Water = water cast at a fixed station, CTD Profile = vertical CTD cast, 6B3 = 60-cm bongo with 333 mesh, 2B3 = 20-cm bongo with 333 mesh, 2B1 = 20-cm bongo with 165 mesh, DIC = Dissolved Inorganic Carbon samples, Nut = nutrient samples, eDNA = environmental DNA samples.

Event	CTD Cast	Station	Deployment	Date	Latitude	Longitude	Depth (m)	Sample Collection
1	1	1	CTD/Bongo Oblique	5-Aug	41.33	-71.44	27	6B3, 2B3
2	2	2	CTD/Bongo Oblique	5-Aug	40.91	-71.01	58	6B3, 2B3
3	3	3	CTD/Bongo Oblique	5-Aug	40.62	-71.91	59	6B3, 2B1
4	4	4	CTD/Bongo Oblique	6-Aug	40.58	-72.01	58	6B3, 2B3
5	5	5	CTD/Bongo Oblique	6-Aug	40.42	-72.16	61	6B3, 2B3
6	6	6	CTD/Bongo Oblique	6-Aug	40.41	-72.42	55	6B3, 2B3
7	7	7	CTD/Bongo Oblique	6-Aug	40.41	-72.83	47	6B3, 2B3
8	8	8	CTD/Bongo Oblique	6-Aug	40.26	-72.92	49	6B3, 2B3
9	9	9	CTD/Bongo Oblique	6-Aug	40.33	-73.83	30	6B3, 2B1
10	10	10	CTD/Bongo Oblique	6-Aug	40.01	-73.91	23	6B3, 2B1
12	11	12	CTD/Bongo Oblique	6-Aug	39.75	-73.74	29	6B3, 2B3
13	12	13	CTD/Bongo Oblique	7-Aug	39.74	-73.26	44	6B3, 2B3
14	12	12	CTD Profile/Water	7-Aug	39.37	-73.39	48	DIC, Nut, eDNA
15	13	15	CTD/Bongo Oblique	7-Aug	39.33	-73.92	30	6B3, 2B3
16	14	16	CTD/Bongo Oblique	7-Aug	39.33	-74.15	24	6B3, 2B1
17	15	17	CTD/Bongo Oblique	7-Aug	39.09	-74.39	26	6B3, 2B3
18	16	18	CTD/Bongo Oblique	7-Aug	38.84	-74.01	46	6B3, 2B3
19	17	19	CTD/Bongo Oblique	7-Aug	38.98	-73.76	43	6B3, 2B1
20	18	20	CTD/Bongo Oblique	7-Aug	38.75	-73.34	74	6B3, 2B3
21	19	21	CTD/Bongo Oblique	7-Aug	39.08	-73.09	72	6B3, 2B3
22	20	22	CTD/Bongo Oblique	7-Aug	39.01	-72.93	92	6B3, 2B1
23	13	23	CTD Profile/Water	7-Aug	39.05	-72.75	179	DIC, Nut, eDNA
24	14	24	CTD Profile/Water	8-Aug	39.01	-72.58	645	DIC, Nut, eDNA
25	21	25	CTD/Bongo Oblique	8-Aug	39.42	-72.33	145	6B3, 2B3
26	22	26	CTD/Bongo Oblique	8-Aug	39.66	-72.66	77	6B3, 2B3
27	23	27	CTD/Bongo Oblique	8-Aug	40.00	-72.51	65	6B3, 2B3
28	24	28	CTD/Bongo Oblique	8-Aug	40.09	-72.09	74	6B3, 2B3
29	25	29	CTD/Bongo Oblique	8-Aug	40.09	-72.01	80	6B3, 2B1
30	26	30	CTD/Bongo Oblique	8-Aug	40.00	-71.76	96	6B3, 2B3
31	27	31	CTD/Bongo Oblique	8-Aug	39.92	-71.42	352	6B3, 2B3
32	28	31	CTD Profile	8-Aug	39.92	-71.42	335	
33	29	32	CTD/Bongo Oblique	8-Aug	39.83	-70.62	930	6B3, 2B3
34	15	32	CTD Profile/Water	8-Aug	39.84	-70.61	877	DIC, Nut, eDNA
35	30	33	CTD/Bongo Oblique	8-Aug	40.05	-70.61	131	6B3, 2B3
36	16	33	CTD Profile/Water	8-Aug	40.05	-70.60	132	DIC, Nut, eDNA
37	31	34	CTD/Bongo Oblique	9-Aug	40.50	-70.83	78	6B3, 2B3
38	32	35	CTD/Bongo Oblique	9-Aug	40.64	-70.62	63	6B3, 2B3
39	17	35	CTD Profile/Water	9-Aug	40.65	-70.61	62	DIC, Nut, eDNA
40	33	36	CTD/Bongo Oblique	9-Aug	40.58	-70.33	61	6B3, 2B3
41	34	37	CTD/Bongo Oblique	9-Aug	40.24	-70.10	97	6B3, 2B3
42	35	38	CTD/Bongo Oblique	9-Aug	40.17	-69.11	131	6B3, 2B3
43	36	39	CTD/Bongo Oblique	9-Aug	40.40	-69.09	84	6B3, 2B3
44	37	40	CTD/Bongo Oblique	9-Aug	40.34	-68.93	91	6B3, 2B3
45	38	41	CTD/Bongo Oblique	9-Aug	40.42	-68.75	85	6B3, 2B3
46	39	42	CTD/Bongo Oblique	9-Aug	40.41	-68.25	125	6B3, 2B3

47	40	43	CTD/Bongo Oblique	9-Aug	40.33	-67.94	142	6B3, 2B3
48	18	44	CTD Profile/Water	9-Aug	40.25	-67.69	1023	DIC, Nut, eDNA
49	19	45	CTD Profile/Water	9-Aug	40.39	-67.69	438	DIC, Nut, eDNA
50	41	46	CTD/Bongo Oblique	10-Aug	40.67	-68.01	84	6B3, 2B3
51	42	47	CTD/Bongo Oblique	10-Aug	40.74	-68.24	66	6B3, 2B3
52	43	48	CTD/Bongo Oblique	10-Aug	40.91	-68.00	50	6B3, 2B1
53	44	49	CTD/Bongo Oblique	10-Aug	40.99	-68.08	54	6B3, 2B3
54	45	50	CTD/Bongo Oblique	10-Aug	41.33	-68.25	50	6B3, 2B3
55	46	51	CTD/Bongo Oblique	10-Aug	41.17	-67.93	53	6B3, 2B3
56	47	52	CTD/Bongo Oblique	10-Aug	41.09	-67.85	51	6B3, 2B3
57	20	53	CTD Profile/Water	10-Aug	40.94	-67.71	64	DIC, Nut, eDNA
58	48	54	CTD/Bongo Oblique	10-Aug	40.75	-67.43	91	6B3, 2B3
59	49	55	CTD/Bongo Oblique	10-Aug	40.67	-67.35	96	6B3, 2B3
60	50	56	CTD/Bongo Oblique	10-Aug	41.08	-67.59	59	6B3, 2B1
61	21	58	CTD Profile/Water	10-Aug	41.46	-67.65	40	DIC, Nut, eDNA
62	51	58	CTD/Bongo Oblique	11-Aug	41.83	-67.81	37	6B3, 2B3
63	52	59	CTD/Bongo Oblique	11-Aug	42.01	-67.83	174	6B3, 2B3
64	22	60	CTD Profile/Water	11-Aug	42.00	-67.69	61	DIC, Nut, eDNA
65	53	61	CTD/Bongo Oblique	11-Aug	41.83	-67.69	36	6B3, 2B3
66	54	62	CTD/Bongo Oblique	11-Aug	41.50	-67.19	53	6B3, 2B3
67	55	63	CTD/Bongo Oblique	11-Aug	41.34	-67.18	53	6B3, 2B3
68	56	64	CTD/Bongo Oblique	11-Aug	40.92	-66.92	86	6B3, 2B1
69	57	65	CTD/Bongo Oblique	11-Aug	40.83	-66.68	205	6B3, 2B3
70	58	66	CTD/Bongo Oblique	11-Aug	41.41	-66.59	88	6B3, 2B3
71	59	67	CTD/Bongo Oblique	11-Aug	41.41	-66.67	82	6B3, 2B3
72	60	68	CTD/Bongo Oblique	11-Aug	41.57	-66.67	76	6B3, 2B3
73	61	69	CTD/Bongo Oblique	11-Aug	41.58	-66.59	80	6B3, 2B3
74	62	70	CTD/Bongo Oblique	12-Aug	41.59	-66.43	90	6B3, 2B3
75	63	71	CTD/Bongo Oblique	12-Aug	41.75	-66.33	82	6B3, 2B3
76	64	72	CTD/Bongo Oblique	12-Aug	41.75	-66.02	100	6B3, 2B3
77	23	73	CTD Profile/Water	12-Aug	41.76	-65.44	2000	DIC, Nut, eDNA
78	65	74	CTD/Bongo Oblique	12-Aug	41.91	-65.84	139	6B3, 2B3
79	66	75	CTD/Bongo Oblique	12-Aug	42.22	-65.77	225	6B3, 2B3
80	24	75	CTD Profile/Water	12-Aug	42.22	-65.76	228	DIC, Nut, eDNA
81	67	76	CTD/Bongo Oblique	12-Aug	42.41	-65.59	93	6B3, 2B3
82	68	77	CTD/Bongo Oblique	12-Aug	42.74	-65.75	106	6B3, 2B3
83	69	78	CTD/Bongo Oblique	12-Aug	42.57	-66.08	140	6B3, 2B3
84	25	79	CTD Profile/Water	12-Aug	43.02	-66.33	134	DIC, Nut, eDNA
85	70	80	CTD/Bongo Oblique	13-Aug	43.08	-66.76	140	6B3, 2B3
86	71	81	CTD/Bongo Oblique	13-Aug	42.67	-66.92	224	6B3, 2B3
87	72	82	CTD/Bongo Oblique	13-Aug	42.50	-66.58	280	6B3, 2B1
88	73	52	CTD Profile	13-Aug	42.49	-66.58	276	
89	74	83	CTD/Bongo Oblique	13-Aug	42.16	-66.92	101	6B3, 2B3
90	75	84	CTD/Bongo Oblique	13-Aug	42.37	-67.04	336	6B3, 2B3
91	26	84	CTD Profile/Water	13-Aug	42.38	-67.03	340	DIC, Nut, eDNA
92	76	85	CTD/Bongo Oblique	13-Aug	42.50	-67.33	326	6B3, 2B3
93	77	85	CTD Profile	13-Aug	42.49	-67.34	325	
94	27	86	CTD Profile/Water	13-Aug	42.70	-67.70	190	DIC, Nut, eDNA
95	78	87	CTD/Bongo Oblique	13-Aug	42.99	-67.93	188	6B3, 2B3
96	79	88	CTD/Bongo Oblique	13-Aug	43.25	-67.67	227	6B3, 2B3
97	80	88	CTD Profile	13-Aug	43.25	-67.68	227	
98	81	89	CTD/Bongo Oblique	14-Aug	43.40	-67.70	248	6B3, 2B3
99	28	89	CTD Profile/Water	14-Aug	43.41	-67.69	242	DIC, Nut, eDNA
100	82	90	CTD/Bongo Oblique	14-Aug	43.50	-67.17	224	6B3, 2B3
100	82	90	CTD/Bongo Oblique	14-Aug	43.50	-67.17	224	6B3, 2B3

101	83	90	CTD Profile	14-Aug	43.50	-67.16	225	
102	84	91	CTD/Bongo Oblique	14-Aug	43.66	-66.84	115	6B3, 2B3
103	85	92	CTD/Bongo Oblique	14-Aug	43.91	-66.58	85	6B3, 2B1
103	85	92	CTD/Bongo Oblique	14-Aug	43.91	-66.58	85	6B3, 2B1
104	86	93	CTD/Bongo Oblique	14-Aug	44.08	-66.84	161	6B3, 2B3
105	29	94	CTD Profile/Water	14-Aug	44.47	-67.21	96	DIC, Nut, eDNA
106	30	95	CTD Profile/Water	14-Aug	44.20	-67.69	110	DIC, Nut, eDNA
107	87	96	CTD Profile	14-Aug	43.98	-68.58	80	
108	88	97	CTD/Bongo Oblique	14-Aug	43.78	-68.65	102	6B3, 2B3
109	31	97	CTD Profile/Water	14-Aug	43.78	-68.66	113	DIC, Nut, eDNA
110	98	97	CTD/Bongo Oblique	15-Aug	43.25	-68.67	161	6B3, 2B3
111	90	99	CTD/Bongo Oblique	15-Aug	43.08	-68.94	145	6B3, 2B3
112	91	100	CTD/Bongo Oblique	15-Aug	43.08	-68.51	195	6B3, 2B3
113	92	101	CTD/Bongo Oblique	15-Aug	42.92	-68.67	200	6B3, 2B1
114	93	102	CTD/Bongo Oblique	15-Aug	42.83	-68.59	175	6B3, 2B3
115	94	102	CTD/Bongo Oblique	15-Aug	42.83	-68.60	180	6B3
116	95	103	CTD/Bongo Oblique	15-Aug	42.50	-68.25	180	6B3, 2B3
117	96	104	CTD/Bongo Oblique	15-Aug	41.92	-68.67	164	6B3, 2B3
118	97	105	CTD/Bongo Oblique	15-Aug	42.33	-68.84	210	6B3, 2B3
119	98	106	CTD/Bongo Oblique	16-Aug	42.50	-69.67	253	6B3, 2B3
120	32	106	CTD Profile/Water	16-Aug	42.49	-69.67	258	DIC, Nut, eDNA
121	99	107	CTD/Bongo Oblique	16-Aug	42.66	-69.75	241	6B3, 2B3
122	100	107	CTD Profile	16-Aug	42.66	-69.74	242	
123	33	108	CTD Profile/Water	16-Aug	43.00	-70.43	103	DIC, Nut, eDNA
124	101	109	CTD/Bongo Oblique	16-Aug	42.91	-70.59	74	6B3, 2B1
125	102	110	CTD/Bongo Oblique	16-Aug	42.76	-70.68	42	6B3, 2B3
126	103	111	CTD/Bongo Oblique	16-Aug	42.42	-70.61	86	6B3, 2B3
127	34	111	CTD Profile/Water	16-Aug	42.43	-70.60	86	DIC, Nut, eDNA
128	104	112	CTD/Bongo Oblique	16-Aug	42.39	-70.51	87	6B3, 2B3
129	35	112	CTD Profile/Water	16-Aug	42.39	-70.50	87	DIC, Nut, eDNA
130	105	113	CTD/Bongo Oblique	16-Aug	42.38	-70.26	49	6B3, 2B3
131	36	113	CTD Profile/Water	16-Aug	42.38	-70.25	52	DIC, Nut, eDNA
132	106	114	CTD/Bongo Oblique	16-Aug	42.41	-70.18	79	6B3, 2B3
133	107	115	CTD/Bongo Oblique	16-Aug	42.25	-70.17	48	6B3, 2B3
134	108	116	CTD/Bongo Oblique	16-Aug	41.74	-69.68	125	6B3, 2B3
135	109	117	CTD/Bongo Oblique	17-Aug	41.52	-69.56	43	6B3, 2B1
135	109	117	CTD/Bongo Oblique	17-Aug	41.52	-69.56	43	6B3, 2B1
136	110	118	CTD/Bongo Oblique	17-Aug	41.24	-69.01	145	6B3, 2B3
137	111	119	CTD/Bongo Oblique	17-Aug	41.09	-68.76	65	6B3, 2B1
138	112	120	CTD/Bongo Oblique	17-Aug	40.92	-68.58	53	6B3, 2B1
139	37	121	CTD Profile/Water	17-Aug	40.90	-69.16	67	DIC, Nut, eDNA
140	113	122	CTD/Bongo Oblique	17-Aug	40.79	-69.15	68	6B3, 2B3
141	114	123	CTD/Bongo Oblique	17-Aug	40.70	-69.39	39	6B3
142	115	124	CTD/Bongo Oblique	17-Aug	40.83	-69.66	35	6B3, 2B3
143	116	125	CTD/Bongo Oblique	17-Aug	40.64	-69.60	52	6B3
144	117	126	CTD/Bongo Oblique	17-Aug	40.67	-69.75	53	6B3, 2B3
145	118	127	CTD/Bongo Oblique	17-Aug	40.59	-69.92	61	6B3, 2B3
146	119	128	CTD/Bongo Oblique	17-Aug	40.75	-70.03	41	6B3
147	120	129	CTD/Bongo Oblique	17-Aug	40.83	-70.15	35	6B3
148	121	130	CTD/Bongo Oblique	17-Aug	40.96	-70.41	43	6B3
149	122	131	CTD/Bongo Oblique	17-Aug	40.98	-70.48	44	6B3
150	38	131	CTD Profile/Water	17-Aug	40.99	-70.48	43	DIC, Nut, eDNA
151	123	132	CTD/Bongo Oblique	17-Aug	41.02	-70.56	45	6B3
152	124	133	CTD/Bongo Oblique	18-Aug	41.08	-70.61	42	6B3, 2B3
153	39	133	CTD Profile/Water	18-Aug	41.08	-70.61	42	eDNA

154	125	134	CTD/Bongo Oblique	18-Aug	41.00	-70.84	50	6B3, 2B3
155	126	135	CTD/Bongo Oblique	18-Aug	40.94	-70.89	52	6B3
156	127	136	CTD/Bongo Oblique	18-Aug	40.94	-71.02	50	6B3
157	128	137	CTD/Bongo Oblique	18-Aug	41.01	-71.02	46	6B3
158	129	138	CTD/Bongo Oblique	18-Aug	41.04	-71.13	40	6B3
159	130	139	CTD/Bongo Oblique	18-Aug	41.08	-71.16	36	6B3
160	40	139	CTD Profile/Water	18-Aug	41.09	-71.16	36	eDNA
161	131	140	CTD/Bongo Oblique	18-Aug	41.13	-71.14	38	6B3
162	132	141	CTD/Bongo Oblique	18-Aug	41.33	-71.00	29	6B3, 2B1
163	133	142	CTD/Bongo Oblique	18-Aug	41.10	-71.16	35	6B3
164	41	142	CTD Profile/Water	18-Aug	41.09	-71.16	36	eDNA
165	134	143	CTD/Bongo Oblique	18-Aug	41.10	-71.16	35	6B3
166	135	144	CTD/Bongo Oblique	18-Aug	41.10	-71.16	35	6B3
167	42	144	CTD Profile/Water	18-Aug	41.09	-71.16	35	eDNA
168	136	145	CTD/Bongo Oblique	18-Aug	41.09	-71.16	35	6B3
169	137	146	CTD/Bongo Oblique	18-Aug	41.10	-71.16	35	6B3
170	43	146	CTD Profile/Water	18-Aug	41.10	-71.16	35	eDNA
171	138	147	CTD/Bongo Oblique	18-Aug	41.09	-71.15	35	6B3
172	139	148	CTD/Bongo Oblique	18-Aug	41.09	-71.17	35	6B3
173	44	148	CTD Profile/Water	18-Aug	41.10	-71.16	35	eDNA
174	140	149	CTD/Bongo Oblique	18-Aug	41.10	-71.16	35	6B3
175	45	149	CTD Profile/Water	18-Aug	41.10	-71.16	36	eDNA

Table 2. Summary of number of stations with deployment and sample collection types for plankton, hydrography, and water sampling at which the NOAA Ship Pisces stopped to lower instruments over the side during Cruise No. PC 21-04. 6B3 = 60-cm bongo with 333 mesh, 2B3 = 20-cm bongo with 333 mesh, 2B1 = 20-cm bongo with 165 mesh, eDNA = environmental DNA samples.

Deployment	Sample Collection	Number of Stations
CTD/Bongo Oblique	Plankton - 6B3	136
	Plankton - 2B2	94
	Plankton - 2B1	20
CTD Profile	Hydrography	7
CTD Profile/Water	Hydrography and Water Samples	34
	eDNA	34
	Nutrients	27
	Dissolved Inorganic Carbon	27

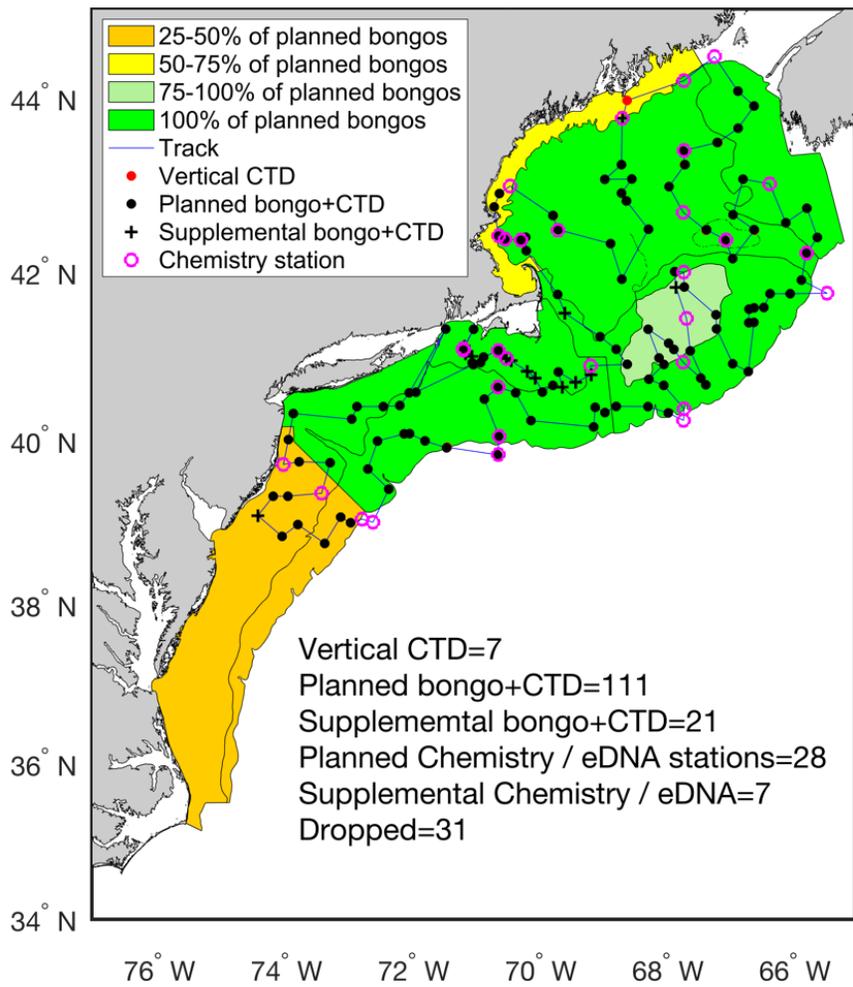


Figure 1. Station locations and percent coverage of bongo sample during Summer Ecosystem Monitoring Survey PC 21-04, 5 – 18 August 2021.



Figure 2. Deployment of 60-cm (bottom) and 20-cm bongo off the a-frame of NOAA Ship *Pisces*.

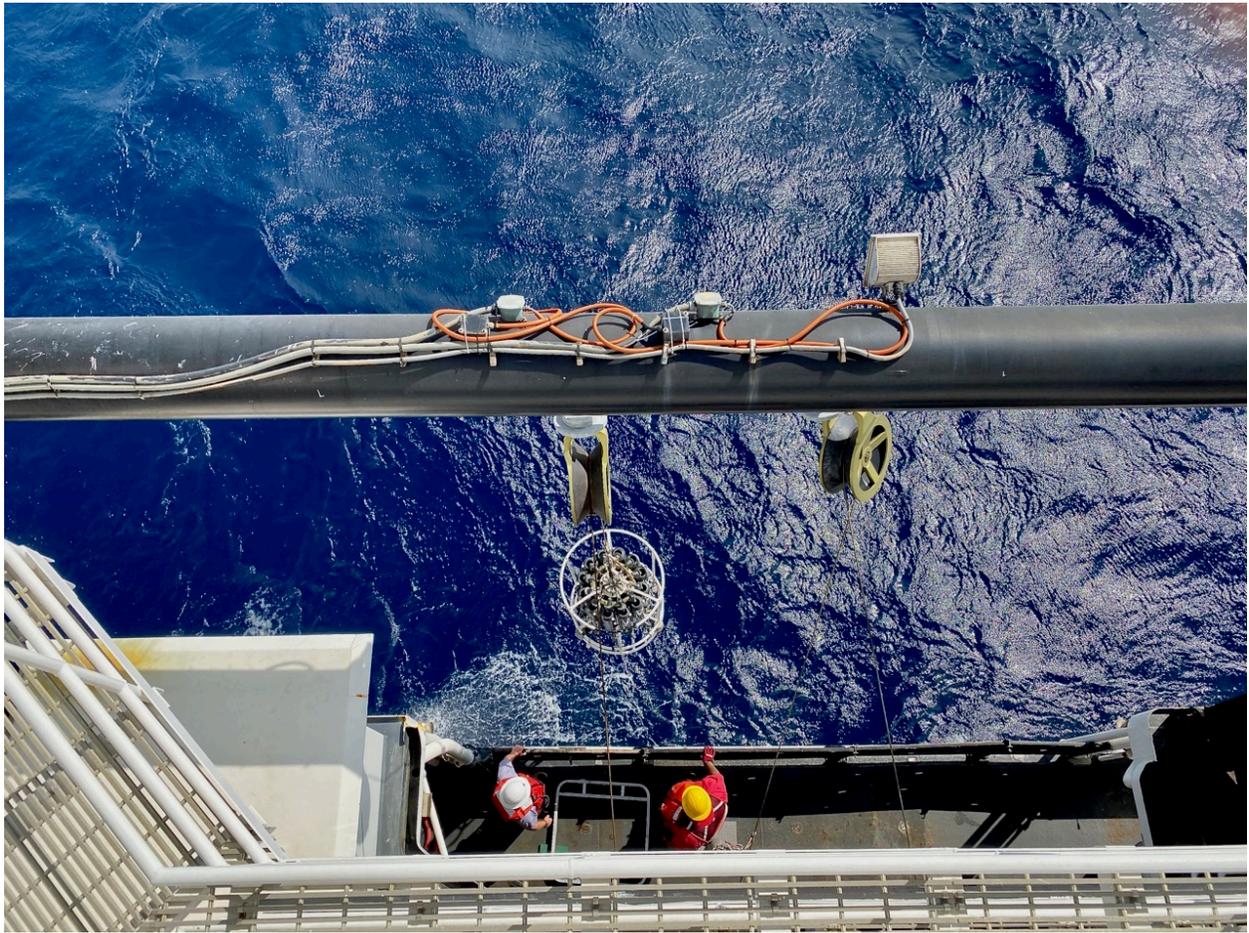


Figure 3. Deployment of water sampling carousel with Conductivity Temperature Depth (CTD) off the a-frame of NOAA Ship *Pisces*.

## *Appendix A*

### Seabird Survey Report

*Marine Species Observers: Allison Black and Doug Gochfeld*

#### Objective:

Collect broad-scale data on the seasonal distribution and abundance of seabirds, marine mammals, marine turtles, and other large fauna using direct visual observations. Collecting seabird and marine mammal data in conjunction with other biotic and abiotic data collected concurrently during Ecosystem Monitoring surveys will help to understand the spatiotemporal distributions of the species and relationships with other trophic levels within the changing marine ecosystem.

#### Methods:

The protocol used for this survey is based on a standardized 300 meter strip transect survey, one that is used by various agencies in North America and Europe (e.g., Anon 2011, Ballance 2011, Tasker 2004). Observers used a SeaScribe program (BRI 2020) for data entry. The SeaScribe app draws GPS coordinates, as well as time from a GPS device via Bluetooth, so each observation received data on the latitude-longitude position, time stamp, and ship's course. The standard data collected for observations included species identification, distance between the ship and the animal, number of individuals, association, behavior, flight direction, flight height, and if possible or applicable, age, sex, and plumage status. While the designers of SeaScribe did not intend the application to collect data on other marine megafauna, observers also recorded other species that were both inside and outside of the 300 m strip survey zone.

During surveys, individual observers took two-hour shifts, to prevent observer fatigue. Observers utilized binoculars (10x42) for general scanning purposes within the survey strip, however, if an animal proved elusive a pair of 20x60 Zeiss imaged-stabilized binoculars were used to attain positive identifications. To aide in approximating distance observers used custom made range finders based on height above water and the observers' personal body measurement (Heinemann 1981).

#### Results:

The observers stood watch on 13 days of the cruise for a total of 93.45 hours of observations. The average daily duration was 7.2 hours (range 0.4 to 10.3). The greatest impact to reduced daily duration was our departure time from port (0.4 hours) and foggy conditions on three days (3.8 hours). They recorded 1269 sightings for a total of 4985 animals over the entire survey.

#### *Seabird Sightings*

Storm-petrels and Shearwaters dominated the seabird sightings (Table A1). Wilson's Storm-petrel and Great Shearwater had the highest total counts. Other notable sightings included shorebirds Red-necked Phalarope and unidentified Phalaropes.

### *Marine Mammal, Sea Turtle, and Large Fishes Sightings*

Dolphins dominated the marine mammal sightings (Table A2). Common and Bottlenose had the highest total counts, but Atlantic White-sided and Risso's Dolphin also occurred. Several large whale species were sighted including Fin, Humpback, Minke, Right, and Sperm whales. Other fauna and marine debris were also recorded (Table A3). Sharks, tuna, and Molas were the most abundant animals. Fishing gear and balloons were the most abundant non-animals recorded.

Table A1. Total Number of birds observed during Cruise No. PC 21-04 aboard NOAA Ship *Pisces*.

Common Name	Number in Zone	Total Count
Wilson's Storm-petrel	1551	1599
Great Shearwater	1276	1436
Unidentified Phalarope	250	255
Audubon's Shearwater	220	220
Red-necked Phalarope	144	144
Leach's Storm-petrel	140	142
Cory's Shearwater	128	132
Great Black-backed Gull	92	94
Herring gull	68	73
Red Phalarope	51	52
Common Tern	21	23
Unidentified large shorebird	0	22
Sooty Shearwater	18	20
Northern Gannet	10	17
Laughing Gull	13	16
Manx Shearwater	5	9
Unidentified small shorebird	0	9
Atlantic Puffin	6	6
Barn Swallow	6	6
Double-crested Cormorant	2	6
Pomarine Jaeger	3	4
South Polar Skua	4	4
Brown Booby	2	3
Least Sandpiper	3	3
Lesser Black-backed Gull	2	3
Semipalmated Sandpiper	3	3
White-faced Storm-petrel	3	3
Cedar Waxwing	0	2
Dovekie	2	2
Tree Swallow	2	2
Unidentified Shearwater	2	2
Unidentified Skua	2	2
Unidentified Storm-petrel	2	2
Unidentified Tern	2	2
Barolo Shearwater	1	1
Brown-headed Cowbird	1	1
Great Skua	0	1
Least Tern	1	1
Long-tailed Jaeger	1	1
Northern Waterthrush	1	1
Ruddy Turnstone	1	1
Unidentified Jaeger	0	1

Unidentified shorebird	1	1
Unidentified Small Shearwater (Audubon's, Manx, or Little)	0	1
Unidentified Warbler	1	1

Table A2. Total Number of marine mammals observed during Cruise No. PC 21-04 aboard NOAA Ship *Pisces*.

Common Name	Number in Zone	Total Count
Common Dolphin	176	248
Bottlenose Dolphin	65	161
Atlantic White-sided Dolphin	65	65
Unidentified Dolphin	10	40
Fin Whale	14	21
Risso's Dolphin	10	20
Humpback Whale	1	5
Minke Whale	4	4
Right Whale	4	4
Unidentified Whale	1	3
Pilot Whale	2	2
Unidentified large whale	0	2
Unidentified small whale	0	2
Long-finned Pilot Whale	0	1
Sperm Whale	1	1
Unidentified Beaked Whale	1	1

Table A3. Total Number of other fauna, fishing gear, and marine debris observed during Cruise No. PC 21-04 aboard NOAA Ship *Pisces*.

Common Name	Number in Zone	Total Count
fixed gear--unidentified	51	51
fixed gear--lobster	25	25
Unidentified tuna	0	25
Mylar balloon	24	24
plastic	20	20
Latex balloon	9	12
Unidentified shark	9	10
Ocean Sunfish (Mola)	3	5
Unidentified ray	3	4
Monarch Butterfly	3	3
Blue Shark	2	2
Portuguese Man o' War	2	2
dragonfly spp.	1	1
Unidentified fish	1	1
Unidentified large fish	1	1

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